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The Influence of Personal Innovativeness and Price Value on Intention to Use of Electric Vehicles in Malaysia

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Abstract

Battery electric vehicles (BEVs) must deal with several concerns, such as battery range, infrastructures, maintenance and spare parts. In other hand, BEVs like any other new technology, have a very small market share at their initial stage. Moreover, with rising attention in global warming, and concerns of possible increase in gas and oil prices in future, several car manufacturers have started producing electric and hybrid cars. These aspects have also attracted people to have intention of using electric cars. In countries having high contribution of renewable energies in electricity production, electric cars have direct effect on healthier environment. The aim of this paper is to study the impact of social influence, facilitation condition, Price value, performance expectancy, and personal innovativeness on intention to use of electric vehicles in Malaysia. Respondents of study were lecturers and postgraduate students in University Technology Malaysia and employees in five companies in Kuala Lumpur. The results of this study evidenced that social influence, price value, performance expectancy, and personal innovativeness have positive influence on intention to purchase of a full electric vehicle. However, the results showed negative influence of facilitating condition on intention to use of BEVs.

Keywords: Electric Vehicles; Green Purchase; Green Technologies; Technology Acceptance Model.

Introduction

While full electric vehicles have been available since long time ago nevertheless they have not been popular. In many countries, electric vehicles are still in initial stage. Car manufacturers are recently producing more and more electric vehicles with more interesting designs. By developing technology, enhancing batteries performances and emerging of environmental worries, electric vehicles are going to be more acceptable in transportation markets. Tesla started mass production of full electric vehicles and produced 24,882 vehicles in Q4, resulting in total 2016 production of 83,922 vehicles. This was an increase of 64% from 2015. Tesla global sales passed the 200,000 unit milestone in March 2017 making the carmaker the second largest global pure electric car manufacturer after the Renault–Nissan Alliance (Kane, 2017).

Customer acceptance is a key to the market success of any emerging product and full electric vehicles are not exemption (Egbue et al, 2012). In any product development, or in early stage of product life cycle, the most important consideration is customer needs (Terninko, J., 2018). This is recognized that buyers have complex desires that can be determined by the buying process (Elliott, A. C. and Wright, I. C., 1999).

Recent increase in greenhouse gasses, made a transformed attention in green products. Currently, automobile exhibitions show more and newer electric vehicles; new models are being produced and being more popular (like Nissan Leaf and Tesla model S, Tesla model 3). States policies

are also shifted to support electric cars usage. Governments offer tax inducements or subsidies for EV buyers in several countries. Increased attention of policy makers and manufacturers toward electric cars is understandable; however, extensive acceptance of electric vehicles is projected to encounter hard-hitting challenges. Charging time, limited or uncertain battery range, lack of enough charging stations, high price of vehicle and spare parts, might be hinders for electric vehicle widespread acceptance. Furthermore, upgrading home facilities and increasing charging stations, may also impose extra issues on electricity network system (Bilotkach, V., & Mills, M., 2012). Economists and market surveyors have been attentive in recognizing the factors that affect the buyer's intention to predict market share, and for that ason, they have introduced numerous models (Marangunić, N., & Granić, A., 2015). Because the introduction of electric vehicles is relatively new in Malaysia, this study is going to determine the factors that are influencing intention to use of electric vehicles in Malaysia.

Literature Review

With the purpose of developing conceptual framework of the study and studying the relevant variables, this section comprises literature review focusing the study variables:

Social Influence

Social influence represents the degree of what a person believes that other people who their idea are important for him or her, think the same way about a new technology (Miao, R. *et al.*, 2016). The construct called subjective norm, in the Theory of Reasoned Action model. In extension of technology acceptance model or TAM2 and unified theory of acceptance and use of technology, social influence characterized as subjective norm, or social factors in some other models. Thompson *et al*. (1991) used the term social norms in defining their theory and recognized its correspondence to subjective norm within Theory of Reasoned Action model. Although they have dissimilar tags, each of these concepts comprises the obvious or implied concept that the person's behavior is influencing by the way which they believe that society will view them as a result of using the technology (Venkatesh et al., 2012). Accepting from (UTAUT 2 model) or Unified theory of acceptance and use of technology, following hypothesis is proposed:

H1. There is a positive significant relationship between social influence and intention of use of BEVs.

Facilitating Conditions

Facilitating condition is defined as individual's insight about infrastructures or technical support existed for using a technology or system (Venkatesh et al., 2012). Considering BEVs, it can be regarded as accessibility of batteries, maintenances, charging infrastructures in home and roads, or after sale services. This relationship adopted from extension of unified theory of acceptance and use of technology theory (Venkatesh et al., 2012).

H2. There is a positive significant relationship between facilitating condition and intention of use of BEVs.

Price Value

Obviously, price value is a very important for potential customers to have intention of buying an electric car. Presently electric cars are more expensive than combustion engine cars although governments try to decrease the price difference by incentives like tax reduction and subsidies. In the context of green products, numerous scholars found price value as one of biggest barriers for green products. Venkatesh *et al. (*2012) argued that price value is a significant factor influencing intention of using a system. Base on discussion above the third hypothesis is generated:

H3: Price value has a positive impact on intention of use of BEVs.

Performance Expectancy

Performance expectancy states the degree that which an individual believes that using a system or technology may support him or her to perform a job better (Venkatesh *et al.*, 2012). This construct represents a person's belief that using a certain technology will be advantageous or performance enhancing to him or her. Venkatesh et al. (2012) proposed performance expectancy as a predictor of using a new technology. Base on discussion above the fourth hypothesis is generated.

H4: Performance Expectancy has a positive impact on intention of use of BEVs.

Personal Innovativeness

It is supposed that those high innovative individuals are generally more aggressive to adopt new idea (Lu *et al.*, 2005). Then, this individual will be easier to meet uncertainties and are more positive about innovations (Rogers, 1983). Agarwal and Prasad (1998) well-defined personal innovativeness as the readiness of a person to test new technologies. According to innovation diffusion theory, Agarwal and Prasad (1998) again claimed a person interpretation of technology is affected by the personal factors. They defined personal innovativeness as a kind of risk-taking tendency that may only happens in specific group of persons and not in others. Therefore, it is important to test this construct in electric vehicles adoption, as a new technology.

H5. Personal Innovativeness has a positive impact on intention of use of BEVs.

Intention to use

(Davis *et. al*., 1989), defined the intention to use a technology as a degree that a person has considered mindful plan to perform or not to perform certain behavior in future. This determines the customers negative or positive feelings towards using new products. The intention of potential customers toward the use of BEV technology along with the associations with independent variables of the research, are the key interests of this specific research.

Conceptual Framework of study

The conceptual framework of the study is shown in figure 1. It defines the variables and relationships between them based on prior theories discussed in literature review. The framework explores the links among social influence, performance expectancy, price value, social influence, and personal innovativeness and intention to purchase electric vehicle.

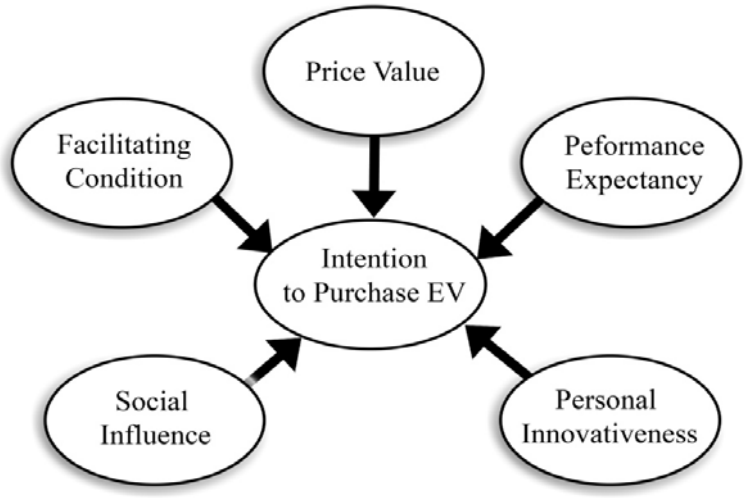

Figure 1. Conceptual Framework of Study

Methodology

This study utilized quantitative method to design questionnaires, and sampling. Data collected by distributing and collecting questionnaires. Purpose of this study was to examine relationships between social influence, performance expectancy, price value and facilitation condition, on intention to use of BEVs in Malaysia.

Data Collection

The primary data in this research, gathered through questionnaires distributed among postgraduates in UTM university and employees in five companies. Questionnaires were designed according to objective of the study. 500 questionnaires were distributed, and 323 responses obtained. After data screening, 312 productive datasets were analyzed.

The demographic characteristics of the respondents were surveyed; principle component analysis (PCA) and Cronbach's alpha were used to examine the validity and reliability of the measurement scale. Then normality test, descriptive analysis, Pearson correlation analysis and lastly multiple regression analysis have been done in this study.

Table 1. Gender frequency

Gender	Frequency	Percent
Female	90	28.8
Male	222	71.2
Total	312	100.0

Measurements

The Items for personal innovativeness adapted from Rogers (2003) and the items for other variables adapted from Venkatesh *et al.* (2012). Respondents were asked to indicate their agreement or disagreement with several statements on a seven-point Likert scale with 1=strongly disagree to 7=strongly agree.

Central Tendencies Analysis for Constructs

The descriptive analysis on mean score of the collected data is presented. Respondents rated factors affecting intention to use of electric vehicles and the level of agreement on factors are showed based on the average of mean.

Table 2. Central Tendencies Analysis for Performance Expectancy

Factor	Item	Std. Deviation	Mean
Performance Expectancy	Using Electric vehicles makes it easier for me to do my job.	0.817	3.71 (moderate)
	Overall, Electric vehicles are useful for me.	0.833	3.62 (moderate)
	Using an electric vehicle improves my daily performance.	0.851	3.28 (moderate)
	Using Electric vehicles enables me to complete tasks more quickly.	0.932	3.70 (moderate)
	Average of Mean		**3.50 (moderate)**

Table 3. Central Tendencies Analysis for Price Value

Factor	Item	Std. Deviation	Mean
Price Value	BEVs are reasonably priced.	0.776	321 (moderate)
	BEVs are a good value for money.	0.811	3.54 (moderate)
	At the current price BEVs provide good value.	0.732	4.44 (high)
	I have intention purchasing an EV.	0.912	3.42 (moderate)
	Average of Mean		**3.65 (moderate)**

Table 4. Central Tendencies Analysis for Social Influence

Factor	Item	Std. Deviation	Mean
Social Influence	People who are important to me think that I should buy electric car.	0.926	3.13 (moderate)
	People usually influence my purchasing intention.	0.928	3.11 (moderate)
	I will use electric vehicles if my friends or peer have already used it.	0.901	3.30 (moderate)
	Average of Mean		**3.18 (moderate)**

Table 5. Central Tendencies Analysis for Facilitating Conditions

Factor	Item	Std. Deviation	Mean
Facilitating Conditions	I have access to facilities and services needed to use BEVs.	0.884	3.01 (moderate)
	I have the knowledge, resources and ability to use electric vehicles.	0.776	3.12 (moderate)
	Resources required to use BEVs are available to me.	0.808	3.14 (moderate)
	My interaction with electric vehicles is clear and understandable.	0.767	3.01 (moderate)
	Using electric vehicle is entirely within my control.	0.757	3.08 (moderate)
	I am constrained by the lack of infrastructure or resources needed to use BEVs.	0.811	3.35 (moderate)
	Average of Mean		**3.12 (moderate)**

Table 6. Central Tendencies Analysis for Personal Innovativeness

Factor	Item	Std. Deviation	Mean
Personal Innovativeness	I regard electric vehicles stimulating and innovative.	0.914	3.04 (moderate)
	I am challenged by ambiguities, new ideas and unsolved problems.	0.953	3.11 (moderate)
	I do not care about other people using an electric vehicle before I consider buying it.	0.974	2.97 (moderate)
	I am generally cautioning about accepting new ideas.	0.930	3.06 (moderate)
	Average of Mean		**3.05 (moderate)**

Table 7. Central Tendencies Analysis for Intention to Use EV

Factor	Item	Std. Deviation	Mean
Intention to Use BEV	I am intended to purchase an electric vehicle.	0.914	3.40 (moderate)
	It is likely that I will use an electric vehicle.	0.893	3.48 (moderate)
	I expect to use electric vehicles in the future.	0.918	3.74 (high)
	Average of Mean		**3.54 (moderate)**

Validity of Measures

This study used PCA with varimax rotation to test the validity of the measurement scale. SPSS 22 used to examine the collected data. Furthermore, Cronbach's alpha was used to test the reliability of the extracted factors. Principle component analysis extracted five dimensions, named facilitating conditions, personal innovativeness, performance expectancy, price value and social influence. These factors loaded well on their respective factor and the results showed the KMO of each variable was greater than minimum of 0.70, indicating a valid scale was used in the data analysis (Hair *et al.*, 2010). The alpha score of each dimension achieved 0.70 and above, indicating a reliable scale used in the data analysis. The results also showed that there is no violation of assumption in the multiple regression analysis. Items in the measurement scale were rated by the respondents. Items for Price value were the most important items, with a mean score of 4.41. The product moment Pearson correlation analysis indicated that there are significant positive correlations between all predictors and intention to *purchase BEVs.*

***Independent* Variables**

The 21 items of the measurement scale for independent variables were subjected to PCA using SPSS version 22. The suitability of data for factor analysis was assessed before performing PCA. Inspection of the correlation matrix revealed the presence of coefficients of 0.3 and above. The KMO was 0.899 which is greater than the recommended minimum of 0.6 (Hair *et al.*, 2010) and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

PCA revealed the presence of five factors with eigenvalues exceeding 1. An investigation of the individual item's MSA revealed that all items' MSA are above 0.50, indicating no item to be omitted from the analysis. Finally, five factors named facilitating conditions (6 items), personal innovativeness (4 items), performance expectancy (4 items), price value (4 items), and social influence (3 items) were extracted and loaded well on their factors and explained 67.98 percent of the variance.

Dependent Variable

The three items of the measurement scale for dependent variable were subjected to PCA using Statistical Package for the Social Sciences (SPSS) version 22. Investigation of the correlation matrix disclosed the attendance of 3 coefficients of 0.3 and above. The KMO was 0.740 and Bartlett's Test of Sphericity achieved statistical significance, supporting the factorability of the correlation matrix. PCA discovered one dimensions with eigenvalues exceeding 1. An inspection of the scatterplots revealed a clear break after the first factor. Subsequently, no cross-loadings and low communalities were found, therefore a model with one dimension may be adequate to represent the dependent variable.

Reliability

No items were deleted, and all the Cronbach's alpha values indicated the reliability of the measurement scale used in this study. Table 8 displays four dimensions with Cronbach's alpha values above 0.80, and two dimensions with values above 0.70.

Table 8. Summary of Reliability Testing

Variable	Dimension	No of Items	Cronbach's Alpha
Independent	Facilitating Conditions	6	0.798
	Personal Innovativeness	4	0.902
	Performance Expectancy	4	0.811
	Price Value	4	0.776
	Social Influence	3	0.802
Dependent	Intention to use EV	3	0.880

Normality, Linearity and Multicollinearity

Examination of normal curve in Histogram showed that the distributions of samples were normal, signifying no violation of the assumption of normality. Moreover, Appendix E displays the normal plot of regression identical residuals for the dependent variables and indicates a relatively normal distribution. It can be observed from the scatter plot of residuals against predicted values, that there is no clear relationship between the residuals and the predicted values, consistent with the assumption of linearity.

There is no violation of multicollinearity if the Tolerance level is more than 0.1 and Variance Inflation Factor (VIF) is less than 10 (Belsley, D., 1991). Table 9 displays the results of Tolerance and VIF tests and shows there is no violation of multicollinearity.

Table 9: The results of Tolerance and VIF tests

	Collinearity Statistics	
Dimension	**Tolerance**	**VIF**
Facilitating Conditions	0.607	1.647
Personal Innovativeness	0.623	1.605
Performance Expectancy	0.786	1.272

	Collinearity Statistics	
Dimension	**Tolerance**	**VIF**
Price Value	0.758	1.319
Social Influence	0.718	1.393

Data Analysis

Pearson Correlation Analysis

In order to test the bi-variate relationships between variables, this study used Pearson correlation technique. The analysis conducted before multiple regression analysis. It can be observed that there are positive correlations among variables ranged from 0.275 to 0.560. Table 10 shows the correlation matrix that identifies the relationships of variables between variables under the correlation significance level of 0.01.

The relationships between independent variables were investigated and the strongest moderate positive relationship between facilitating conditions and social influence (r = 0.560, p = 0.000). This indicates that high levels of facilitating conditions associated with high levels of social influence. A very weak positive relationship is observed between social influence and Price Value (r = 0.275, p = 0.000). There is low positive relationships between performance expectancy and facilitating conditions (r = 0.386, p = 0.000); price value and facilitating conditions (r = 0.356, p = 0.000); personal innovativeness and facilitating conditions (r = 0.311, p = 0.000); Price Value and performance expectancy (r = 0.329, p = 0.000); personal innovativeness and performance expectancy (r = 0.332, p = 0.000). In addition, there are moderate positive relationships between independent variables, social influence and performance innovativeness (r = 0.416, p = 0.000), From the analysis, it is obvious intention to use is associated with the high level of facilitating conditions, personal innovativeness, performance expectancy, price value and social influence. Nevertheless, the correlation is ranged from very weak position relationship to moderate positive relationship (r = 0.276 to 0.527). It can be noticed that the strongest positive association exists between performance expectancy and intention to use EV (r = 0.527, p = 0.000) and the weakest positive relationship between facilitating conditions and intention to use BEV. The results of Pearson correlation analysis are shown in table 10.

Table 10. Correlations of Factors Influencing Intention to Use BEVs

		Facilitating Conditions	**Social Influence**	**Performance Expectancy**	**Price Value**	**Personal Innovativeness**	**Intention to use EV**
Facilitating Condition	**R**	1	0.560	0.386	0.356	0.311	0.276
	Sig		0.000	0.000	0.000	0.000	0.000
Social Influence	**R**	0.560	1	0.283	0.275	0.416	0.464
	Sig	0.000		0.000	0.000	0.000	0.000
Performance Expectancy	**R**	0.386	0.283	1	0.329	0.332	0.527
	Sig	0.000	0.000		0.000	0.000	0.000
Price Value	**R**	0.356	0.275	0.329	1	0.404	0.435
	Sig	0.000	0.000	0.000		0.000	0.000
Personal innovativeness	**R**	0.311	0.416	0.332	0.404	1	0.497
	Sig	0.000	0.000	0.000	.000		0.000
Intention to Use BEVs	**R**	0.276	0.464	0.527	0.435	0.497	1
	Sig	0.000	0.000	0.000	.000	0.000	

Multiple regressions were carried out to inspect the research hypotheses. Initial analyzes were led to certify no violation of the assumptions of normality, linearity, and multicollinearity. The Durbin-Watson statistic also displays that there is no autocorrelation with the statistic value of 2.112 falls within the acceptable range of 1.5 to 2.5 as recommended by Norusis (1995). The autocorrelation test result is showed in Table 11.

Table 11. Model Summary[b] and Durbin-Watson Test for Autocorrelation

R	R Square	Adj. R Square	F	Sig.	Durbin-Watson
0.696[a]	0.485	0.467	73.012	0.000	2.112

Table 11 displays F statistic for the model is 73.012 with P value of 0.000, signifying the significance of model. This specifies that the predictors are significantly influenced the dependent variable which is intention to use of BEVs. The R square of 0,467 clarifies that 46.7% of the variance had been significantly explained by the independent variables. Moreover, standardized regression is identified, and the results are showed in Table 12. It indicates that performance expectancy had highest beta value, 0.387, followed by personal innovativeness (b = 0.323), social influence (b = 0.233), price value (b = 0.203) and facilitating conditions (b = -0.192).

Table 12. Standard Coefficient of Dimension

Dimension	Std. Coefficients (Beta)	P Value.
Performance Expectancy	0.387	0.000
Price value	0.203	0.000
Social Influence	0.233	0.000
Facilitating Conditions	-0.192	0.000
Personal Innovativeness	0.323	0.000

Results and Discussion

Table 13 demonstrates the Summary of hypothesis testing.

Table 13. Summary of Hypothesis Testing

Hypotheses	Results
H1: Social influence has a positive impact on intention to use electric vehicles.	Accepted
H2: Facilitating conditions has a positive impact on intention to use electric vehicles.	Rejected
H3: Price value is positively influencing the intention to adopt electric vehicles.	Accepted
H4: Performance expectancy has a positive impact on intention to use electric vehicles.	Accepted
H5: Personal innovativeness has a positive influence on intention to use electric vehicles.	Accepted

Social Influence

Regression analysis was conducted to test the relationship between social influence and intention to use BEVs. The result of this study supports hypothesis 1 that social influence has a positive effect on intention to use electric vehicle as a new technology (b = 0.233, p = 0.000). Yee, Y.

Y., and Yeow, P. H. P. (2009) claimed that younger generation more imitate the group of peers whom they are socialized, consequently, social influence plays an important impact in this study since majority of respondents of this study were young students. Thus, social influence has significant affect towards intention to use electric vehicles among respondents of this research. As there are environmental benefits of using BEVs, they can be amplified through the social influence on people. Giving governmental incentives for customers may be a good technique to attract more customers to use BEVs. For marketing implications, high social influence also indicates that media or press plays important role in attracting attention towards electric vehicles.

Facilitating Conditions

Regression analysis was conducted to test the relationship between facilitating conditions and intention to use BEV. The results of the analysis were presented in Table 7. The results of this study rejected hypothesis 2 that facilitating conditions (b = -0.192, p = 0.000) has no positive effect on intention to use BEV. According to Axsen and Kurani (2013), the most frequent concerns with BEVs are limited range, charger availability, and higher vehicle purchase prices. Therefore a good explanation for this result could be that accessing to the necessary technology support is a serious problem to the respondents since there is not enough infrastructures such as charging stations and after sale services are available in Malaysia yet.

Price value

The relationship between price value and intention to adopt BEV was examined in the multiple regression analysis and the result supports hypothesis 3 that price value has positive effect on intention to adopt BEVs (b = 0.203, p = 0.000). These finding is not consistent with some previous studies. Price value is barrier for some new technologies (Kveiborg, O., Christensen, L., Mabit, S.L., 2010). That is interesting because although price of electric cars in same class are more than combustion engine cars, but in this study, the respondents still found the price reasonable. It can be because most of the respondents were educated and understand the higher price of new technology at early stage, or they may perceive BEVs as more effective and economic in long time usage comparing with combustion engine cars.

Performance Expectancy

Regression analysis was conducted to test the relationship between performance expectancy and intention to use BEVs. The result of this study supports hypothesis 4 that performance expectancy (b = 0.387, p = 0.000) has a positive effect on intention to use electric vehicles and is consistent with similar previous studies. A rational reason could be used to explain this consistent finding, Skippon (2014) stated that the future dynamic performance and cruising performance of electric vehicles might partially offset the reduced utility of low range, long recharge times, and higher costs. So perceived overall driving performance, including the comfortable driving, high acceleration and smoothness noise free driving of electric vehicles could be a very rational motive for having intention to buy BEVs.

Personal Innovativeness

Regression analysis was conducted to test the relationship between personal innovativeness and intention to use EV. The results of the analysis were presented in Table 7. The results of this study support hypothesis 5 that personal innovativeness (b = 0.323, p = 0.000) has a positive effect on intention to use BEVs. Rogers (2003) argued, early adopters are small group who have high level of innovativeness. According to Kerr, William R., & Ramana Nanda (2015), innovation is associated with greater risk, uncertainty, and imprecision, so innovators are able to cope with higher levels of uncertainty. Therefore, in EV context, which is a revolutionary technology and needed different habits, views and still uncertainties such as range anxiety and scarcity of charging stations,

personal innovativeness amplifies risk-taking behavior and serves as a key motivator for purchasing electric vehicle.

Conclusion

This study has been done in Kuala Lumpur, Malaysia and investigated the factors that influence individual intention towards usage of battery electric vehicles. This research proposes a new conceptual framework in automotive concept. The results of this study proved that social influence, price value, performance expectancy, and personal innovativeness have positive influence on intention to purchase of an electric vehicle. However, the positive effect of facilitating condition on intention of use of electric vehicles was not supported.

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